LANCASTER, NEW HAMPSHIRE

LOCAL ICE-JAM FLOOD CONTROL PROJECT

ISRAEL RIVER

REVISED SUPPLEMENT

TO

DETAILED PROJECT REPORT

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

February 1978

LANCASTER LOCAL PROTECTION PROJECT
ISRAEL RIVER, CONNECTICUT RIVER BASIN
LANCASTER, NEW HAMPSHIRE

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Lancaster Local Protection Project

Israel River, Connecticut River Basin

February 1978

Pertinent Data

1.	Purpose	Local Ice-Jam Flood Protection
2.	Location	Israel River, Town of Lancaster, Coos County, New Hampshire
3.	Type of Improvement	Gabion overflow weir and 3 ice holding gabion cribs to hold floating ice during spring runoff

4. Hydrology

Maximum flood of record without ice

Discharge	8,840 cfs (Nov. 1927)
Elevation	863.5 feet, msl

Maximum flood stage of record with ice

Elev. 866.6 feet, msl (Mar. 1968)

Drainage area	133 square miles

5. Proposed Gabion Dam

Length	163 feet
Top Elevation	844 feet, msl
Maximum Height above streambed	7 feet

(pertinent data cont'd)

6. Cost Estimates

First Costs	
Federal	$142,000
Non-Federal	8,000
Total	$150,000
Annual Costs	
Federal	$ 11,800
Non-Federal	1,400
Total	$ 13,200

7. Benefits

Average Annual Benefits	$ 46,000
Benefit-Cost Ratio	3.5 to 1.0

A. AUTHORITY

This supplement to the previously submitted Detailed Project Report dated September 1973 is submitted in accordance with authority contained in Section 205 of the 1948 Flood Control Act, as amended. Authority is also contained in the 1st Indorsement dated 20 December 1973 approving the DPR, entitled "Local Ice-Jam Flood Protection, Israel River, Lancaster, New Hampshire." On 16 October 1974, funds in the amount of $10,000 were received to perform field surveys of an alternative site and to produce this supplemental report.

B. BACKGROUND INFORMATION

During March 1970, under authority contained in Public Law 99, an emergency rock dike was constructed across the Israel River just upstream from the Otter Brook confluence. (See Plate No. 1) This structure was intended to be capable of holding floating cover ice from the upper watershed until a permanent dam could be constructed just downstream from the confluence.

During September 1973 a Detailed Project Report (DPR) recommending construction of a concrete overflow weir to prevent ice-jam flooding along the Israel River in Lancaster was forwarded to the Chief of Engineers and was subsequently approved on 20 December 1973. Severe ice jamming which occurred in March 1974, however, made it necessary to reformulate the plan of improvement as outlined in the DPR. Much of the information contained in the approved DPR is still valid and should be utilized as background data. This letter-type report presents a revised plan and is considered a supplement to the approved 1973 DPR.

During March 1974 thawing conditions on the Israel River caused the release of an ice jam which had formed below the rock dike constructed in 1970 in a reach which extended 1.5 miles to the center of town. The rock dike was effective in holding ice from upstream areas. However, there was sufficient ice generated from below the rock dike to cause a jam in the center of town, flooding several buildings and other properties. Following the March 1974 flood, town officials withdrew their support of the plan to construct a permanent structure near Otter Brook as described in the approved DPR. The New England Division asked the Cold Regions Research and Engineering Laboratory (CRREL) to reevaluate its previous recommendations which formed the basis for the September 1973 DPR. In August 1974, CRREL recommended that an alternative site closer to town be investigated for the construction of a low dam. Accordingly, funds were requested to investigate an alternative site.

During the interim 3-year period, additional studies were made in cooperation with CRREL, U. S. Fish and Wildlife and local officials. Alternative designs of ice holding structures were investigated which were finally indorsed by local interests on 28 June 1977. This was followed by indorsement by the New Hampshire Water Resources Board on 29 December 1977.

C. PURPOSE

This supplemental report investigates the feasibility of constructing a flood control dam at an alternative site immediately upstream of the center of Lancaster, New Hampshire to control ice and prevent the recurrence of future ice-jam flooding. As already noted, the March 1974 flood was caused by an ice jam that formed in the 1.5-mile reach of the river between the rock dike constructed in 1970 and the center of Lancaster.

Two favorable site locations were identified in this 1.5-mile reach, both of which were once sites of two earlier wooden dams, owned and operated by the Twin State Gas & Electric Company. These timber dams were destroyed by ice jams several years ago. Although the primary function of these dams was to provide for the production of hydropower, a secondary benefit was realized as protection was afforded by preventing downstream movement of ice jams. The site of the lower dam, approximately 0.5 miles upstream of Lancaster center, was chosen as the new site for an ice-jam flood control structure as reported herein.

D. HYDROLOGY

Owing to the complex factors which produce ice-jam flooding in the Israel River there is little or no correlation between natural river discharges and ice-induced stages. Therefore, separate elevation-frequency curves have been estimated for non-ice and ice-jam floods.

Because there are only sporadic discharge records for the ungaged Israel River, discharge records indicate that the Israel River has not experienced as proportionately large a non-ice flood as other adjacent watersheds. This is probably due to orographic influences since the river rises on the western slopes of the Presidential Range of the White Mountains. Discharge-frequency relationships were determined for non-ice floods on the Israel River at Lancaster from a regional analysis of the upper Connecticut River Basin. These relationships were developed by procedures set forth in ER 1110-2-1450, dated October 1962. A tabulation of the estimated discharge-frequency relationship for non-ice floods at Lancaster is shown in the following table.

DISCHARGE-FREQUENCY DATA
NON-ICE FLOODS
ISRAEL RIVER, MAIN STREET BRIDGE
(DA = 133 square miles)

Frequency or Per Cent Change of Occurrence	Discharge (cfs)	Water Surface Elevation (ft., msl)
1.0	21,000	865.5
2.0	12,000	864.1
5.0	5,400	862.1
10.0	4,100	860.5
20.0	3,100	858.8
30.0	2,800	858.0
40.0	2,500	857.5
50.0	2,400	857.2

It is considered appropriate to examine high river stages produced by ice-jams in an entirely different statistical array from the stages related directly to high stage flow without ice. Since data for maximum stages produced by ice-jams are meager and their causes do not follow any specific meteorological pattern, it is not possible to apply a sound mathematical approach to determining a probability relationship. The March 1968 ice-jam on the Israel River in Lancaster is its greatest flood of record. Prior to 1936, a few ice-jam floods were reported in this area. Several dams on the Israel River were destroyed in 1936 and since that time ice-jam flooding has been a more frequent occurrence. The March 1968 flood is considered a 33-year event and assigned a 3 percent exceedence frequency. The second highest ice-jam stage in recent years occurred in April 1950 and was assigned an exceedence frequency of 10 percent. A tabulation of elevation-frequency data for ice-jam floods is shown in the following table.

ELEVATION-FREQUENCY DATA
ICE JAM FLOODS
ISRAEL RIVER, MAIN STREET BRIDGE

Frequency of Per Cent Change of Occurrence	Ice-Jams (ft., msl)
1.0	868.6
2.0	867.5
5.0	865.4
10.0	863.8
20.0	861.7
30.0	860.5
40.0	859.5
50.0	858.8

E. FLOOD DAMAGES & AVERAGE ANNUAL LOSSES

Approximately 12 acres of commercial, industrial and residential properties in Lancaster are subject to ice-jam flooding. They contain 21 commercial properties, the Town Hall, one small industrial plant (45 employees) and 15 dwellings in the town's center. Based on assessments for properties and contents, the estimated value of these flood-prone properties exceeds $1,200,000.

Flood damage surveys were made of the area following the ice-jam floods of March 1964 and May 1968. These have been updated to current 1977 price levels. Affected property owners were interviewed and the town manager and other public officials were consulted. Estimates were made of the damages in the 1968 event and for stages above and below the 1968 water level.

A recurrence of the 1964 (Stage 859.5) event would cause estimated losses of $11,600 under 1977 conditions. In a recurrence of the 1968 ice-jam flood of record (Stage 866.6), losses would amount to $149,900.

Recurring losses at various stages of flooding were combined with stage-frequency data for conditions with and without ice to determine annual losses. Annual losses amounted to $56,200 with ice and $9,500 without ice at current price levels.

F. PLAN FORMULATION

Physical conditions of the alternate site are considerably different from those of the upstream area. The dam site near Otter Brook as reported in the DPR had (56 acres) flood plain and a flat stream gradient that allows accumulation and gradual wastage of ice. The preferred downstream site is located in a narrow flood plain with a steep channel gradient. A low overflow weir structure capable of retaining ice is being recommended at this location. CRREL is satisfied with the rock dike constructed in 1970 and built across the Israel River upstream of the point where Otter Brook enters the Israel River. The rock dike has been successful in its purpose i.e., no ice has passed this location since its construction. Ice problems experienced since 1970 at Lancaster have been caused by ice from Otter Brook or by ice formed below the rock dike. Based upon CRREL observations, it was determined that Otter Brook contributes little ice to the jamming problem and, that the previously proposed dam, situated just downstream of the confluence, although it would diminish severity of ice jams, would not solve the Lancaster ice-jam problem. Further CRREL proposals recommended that the former dam site located upstream and around the first corner from the covered

bridge, as noted on Plate 1, should be used as the selected site. A dam constructed at this location would create a pond extending about 800 LF upstream. The existing rock dike will be maintained by the town to prevent ice from the upper reaches of the Israel River from moving downstream to the selected site. An alternative approach was evaluated consisting of 3 weirs, each with a drop of about 3 feet. The entire river from the Main Street bridge to the railroad bridge would become a series of shallow pools each freezing over. This alternative was found to be more costly than the selected site and was found to lack justification.

CRREL has reviewed the plans of the proposed gabion weir and provided the following comments as attached to this report.

"The current approach is a compromise between either a resurrection at the site of a dam to the full height of the previous power dam or a series of low weirs. Without the type of model testing which will only become possible after the construction of the CRREL proposed Ice Engineering Facility, any proposal is at best an educated guess. We believe this 6 or 7-foot weir will solve the problems at Lancaster. It it does not, we feel that one or two additional low weirs will surely be sufficient.

Due to the experimental nature of this solution, it is definitely advantageous to proceed in a step-by-step fashion so that we don't build unnecessary structures so that we can learn what minimum effort will solve the problem. Along this line of thought, construction of the proposed cribs, upstream of the weir, might be deferred. This is a very rough stream with large boulders that may break up the moving ice more effectively than will some cribs. This large floating ice sheet which we expect to achieve with the weir will freeze early, gain extra thickness from frazil deposited on its bottom, and be stronger which will be fixed to the shore, and will hold back that moving ice which comes down from upstream."

Three types of small overflow dams were considered during this supplemental study: timber crib; concrete; and gabion weirs. The advantages and disadvantages of each type were recognized and evaluated. The decision for the most suitable type of dam was based upon the economic, social and environmental impacts of each alternative. Other methods of protection (log booms, dikes, channel improvements) had been studied in detail during previous investigations and were found to be unacceptable. Descriptions of alternative plans for ice-jam flood protection are as follows:

Timber Crib Dam

Since timber is plentiful in New England's north country, this alternative has the lowest initial cost. However, unlike cedar, redwood and cypress, which would afford a 30 to 40-year expectancy the use of pine and fir or other native types of lumber would drop the life span to a 10 to 20 year level. In addition, since wooden dams are susceptible to damage from the expansion of ice, it is estimated that local maintenance costs for a structure of this type would be excessively high.

Concrete Dam

The concrete dams considered consisted of low reinforced structures that require a minimal amount of maintenance as concrete is less prone to ice damage than any other materials considered. The initial cost of a concrete structure was found to be between 1.5 and 2 times higher than similar timber and gabion structures.

Gabion Dam

This plan examined the use of gabions, which are rock filled, galvanized steel baskets. This structure would cost a little more than a timber dam but significantly less than a concrete dam. Higher cost would be offset by the savings in maintenance over the timber crib dam. Maintenance required consists of weaving crib wire to repair breaks in gabion baskets, should they occur. Repairs of this nature are considered minimal since the galvanized material would be poly-vinyl coated to resist abrasion and corrosion. With proper care the structure can be expected to perform satisfactorily for 50 years or more. In addition, since the gabions are porous, hydrostatic pressures would be less than those for a concrete structure. The esthetics of the area would not be affected significantly as the appearance of such a structure blends well with the surrounding terrain.

G. THE RECOMMENDED PLAN

The proposed improvement would consist of a gabion overflow weir across the Israel River, just upstream of the covered bridge at the site of a former Twin State Gas & Electric dam and approximately 0.5 miles upstream of the Main Street bridge. The length of the weir would be approximately 162 feet with a crest elevation of 884 feet above mean sea level (msl). The top width of the dam would be 3 feet with a vertical downstream face and a 45 degree slope of the upstream face. A 4-foot wide opening located at midstream would allow the passage of fish during summer low flow periods. The dam would be built on a mattress made of 9-inch thick gabions filled with stone and would cover an area approximately 45 feet by 162 feet.

Three rock-filled gabion ice holding cribs would be constructed upstream of the spillway to act as ice holding structures. The cribs would have a top approximately 9 feet by 6 feet in size with the upstream face sloped to a 9 feet by 15 feet rectangular base.

An impervious earthfill dike would be constructed across a low swale near the left dam abutment. The structure would be about 90 feet long and would have a maximum height of 10 feet. It would have an 18-inch layer of stone slope protection on the riverside face to prevent scour from ice.

A plan, profiles and sections, and an isometric view of the weir and appurtenant structures are shown on Plates 2, 3, and 4.

In addition to the proposed construction at the new site, it was deemed prudent to reinforce the existing rock dike upstream as this is considered an integral part of the solution to the ice-jam flooding. At the present time the town of Lancaster places a "submarine" net across the center section of the rock dike prior to arrival of cold weather. The net catches floating debris which forms a barrier that in turn allows a sheet of cover ice to build up behind the rock dike during the winter. During thaw periods and during the spring freshets this ice cover holds floating ice from upstream areas, thereby preventing it from jamming in the central business district of Lancaster. This project, constructed under emergency authorities in 1970, has been successful although some scour occurs around the right end of the rock dike during the spring runoff period. Proposed reinforcement of the rock dike would include placement of an "apron" to prevent further scour and reinforcement of the existing structure with additional larger stone.

H. BENEFIT-COST ANALYSIS

The estimates of Federal and non-Federal first costs and annual charges are given in Table I.

Non-Federal interests would be required to furnish all lands, easements, and rights-of-way needed for construction and to operate and maintain the project upon its completion. Unit prices used in estimating costs were based on average prices for similar work in the general area. Unit costs are based on 1977 price levels, and they include minor items of work which are not separately detailed.

Annual charges are based on a project life of 25 years, Federal and non-Federal annual charges, calculated using an amortization rate of 6-5/8% were estimated to be approximately $11,800. In addition, estimated annual operation and maintenance, which are local responsibilities, would cost about $1400 for total annual charges of $13,200.

Average annual flood damage prevention benefits from ice-jam floods were measured as the difference between annual losses due to ice jam floods under current conditions and annual losses to be expected without ice. Annual benefits, so derived, amount to $46,000. When compared with a total annual charge of $13,200, the resulting benefit-cost ratio is 3.5 to 1.0. 46,700

I. IMPACT ASSESSMENT

Beneficial impacts associated with construction of the project includes a reduction of the potential for ice-jam flooding of the central business district in Lancaster. This reduction would also provide protection for residential property located adjacent to the central business district.

Adverse impacts are minimal. Short-time sedimentation and siltation problems are associated with project construction; however, measures would be taken during construction to minimize this problem.

The esthetics of the area would not be adversely affected by project construction. The natural appearance of the stone-filled gabions would blend in with the undeveloped areas adjacent to the site. Since the gabions are 30 percent porous, no significant ponding would occur behind the weir and hence there would be little effect on the fish and wildlife of the area.

The project was also evaluated in relation to the NED, EQ, SWB and RD accounts as presented in the Principles and Standards regulations (ER 1105-2-200 series). The results of the evaluation follow:

(1) The National Economic Development

The proposed project would have a net positive effect on the gross national product. A comparison of project benefits versus project costs shows an excess of benefits, hence an increase in the value of the Nation's output of goods and services.

(2) Environmental Quality

The proposed project would accomplish the objective of providing ice-jam flood protection with a minimum of disruption to the environment. No long-term sedimentation and siltation problems are anticipated.

(3) Social Well-Being

By reducing the threat of ice-jam flooding in Lancaster, residents can continue to live in the area without undue economic and physical stress. Elimination of disruption and damage to the environment will conserve the energy and money presently dispersed to repair damages caused by ice and water.

(4) Regional Development

According to January/February 1977 U.S. Department of Labor Report - Area Trends in Employment and Unemployment, Lancaster is an area of concentrated unemployment or underemployment, therefore, construction of the project would create temporary new jobs for the region's workforce, and this, in turn, would increase revenue for the town and county. In addition, protection of the central business district could initiate an increase in development by local merchants and the town of Lancaster.

J. SCHEDULES FOR DESIGN AND CONSTRUCTION

Pending approval of this report, it is estimated that preparation of contract plans and specifications for the project would cost $15,000 and be completed in 6 months. Funds for construction would be required upon completion of plans and specifications. Construction of the project could be accomplished under a single contract during a 6-month period.

K. OPERATION AND MAINTENANCE

Maintenance of this project will be the responsibility of local interests. Periodic inspection will be made by the Corps to ensure that adequate maintenance is performed in accordance with regulations prescribed by the Secretary of the Army. It is estimated that maintenance and operation of the project will cost local interests $700 annually. An operation and maintenance manual will be provided to the town of Lancaster upon completion of the project.

L. LOCAL COOPERATION

In accordance with section 205 of the 1948 Flood Control Act, as amended, local interests are required to provide without cost to the United States, all lands, easements, rights-of-way, utility relocations and alterations necessary for the construction and operation of the project, including disposal areas. They must hold and save the United States free from damages due to the construction work and adjust all claims concerning water rights. They must maintain

and operate all the works after completion in accordance with existing regulations prescribed by the Secretary of the Army. Local interests are also required to furnish added assurance that they would contribute to the United States all necessary funds over and above the Federal cost limitation of $2,000,000 should this become necessary. Town officials have indicated a willingness to fulfill conditions of local cooperation. A letter of intent from the Lancaster Town Manager is attached to this report.

M. COORDINATION WITH OTHER AGENCIES

Plans for local protective works in Lancaster have been reviewed by officials of the town of Lancaster, the State of New Hampshire and Federal agencies. A letter of intent from the town of Lancaster and a Conservation and Development Report, prepared by the U.S. Department of the Interior, Fish and Wildlife Service, are attached. The report basically supports construction of the proposed ice-jam flood prevention structure.

N. CONCLUSIONS

The town of Lancaster faces the threat of significant damages in future floods. The threat of annual ice-jam flooding is a continuing burden upon the town, which has the tendency of lowering real estate values. The area is listed as depressed by the U.S. Department of Labor and it relies largely on its recreation-tourism business for survival.

Local interests desire the best form of protection that can be afforded to their commercially developed area in order to secure the economic base of the town. Solution of the ice-jam flood problem is beyond the town's financial capability. The project is economically justified by the ratio of annual benefits to annual costs of 3.5 to 1.0. The threat of recurring damaging ice-jam floods makes it desirable to construct the project as soon as possible.

O. RECOMMENDATION

It is recommended that funds in the amount of $15,000 be provided for completion of plans and specifications.

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl:
Table 1 - Estimates of first Costs and Annual Charges
Plates 1-4
Letter of Intent
US Fish & Wildlife Service
C&D Report
CRREL Report

TABLE 1

ESTIMATES OF FIRST COSTS AND ANNUAL CHARGES
LOCAL FLOOD PROTECTION PROJECT
LANCASTER, NEW HAMPSHIRE
FIRST COST
(1977 Price Level)

FEDERAL COST

Item	Quantity	Unit	Unit	Amount
Site Preparation	1	Job	L.S.	$ 4,000
Stream Control	1	Job	L.S.	5,000
Excavation and Spoil	400	C.Y.	6.00	2,400
Gabion Baskets				
6' x 3' x 3'	35	each	45.00	1,575
9' x 3' x 3'	90	each	60.00	5,400
12' x 6'6" x 9"	60	each	90.00	5,400
10' x 6'6" x 9"	35	each	75.00	2,625
8' x 6'6" x 9"	15	each	65.00	975
4' x 6'6" x 9"	2	each	40.00	80
Stone Fill	600	C.Y.	25.00	15,000
Compacted Impervious Fill	350	C.Y.	8.00	2,800
Stone Slope Protection	50	C.Y.	20.00	1,000
Gravel Bedding	40	C.Y.	15.00	600
Reinforce Rock Dike	1	Job	L.S.	25,000
Overhead, Profit & Bond	1	Job	L.S.	10,000
Sub-Total				$ 81,855
Contingency				20,145
TOTAL CONSTRUCTION COST				$102,000
Engineering and Design				25,000
Supervision and Administration				15,000
TOTAL ESTIMATED FEDERAL COST				$142,000

NON-FEDERAL COST

Land and Damages	$ 8,000
TOTAL ESTIMATED PROJECT FIRST COST	150,000

TABLE 1 (Continued)

ANNUAL CHARGES

Federal		
	Interest and Amortization (.08293 x 142,000)	$ 11,800
Non-Federal		
	Interest and Amortization (.08293 x 8,000)	700
	Maintenance	700
	TOTAL ANNUAL COST	$ 13,200